AWA Experiments

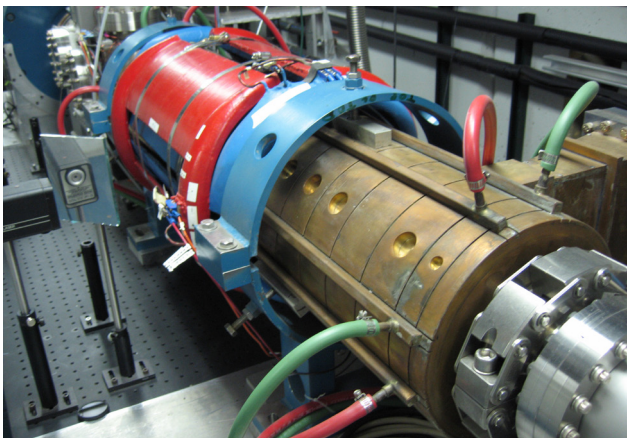
Photonic Band Gap (PBG) structures, with their capability for single mode confinement, are attractive for future particle accelerator design that requires large transverse deflecting wakefield mode suppression (severe transverse wakefield will cause beam breakup). However, wakefield modes, including the monopole (accelerating) and dipole (deflecting) modes generated in a PBG by an electron beam, have never been clearly characterized in a beam test.

The Challenge

To generate, identify and characterize the fundamental (monopole) and higher order modes (HOMs) of wakefields using a precise position-controlled electron beam.

The Solution

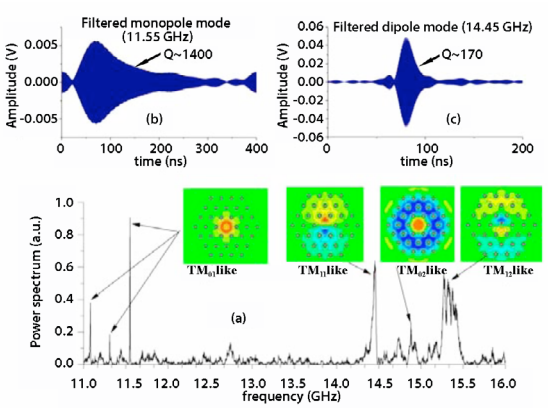
The Argonne Wakefield Accelerator (AWA) group, in collaboration with Tsinghua University of China, designed and fabricated an Xband, three-cell, PBG-accelerating structure using a two-dimensional triangular lattice of copper rods between two copper plates. This structure was successfully beam-tested at the AWA beamline in September 2009.



Argonne Wakefield Accelerator

The Results

- The accelerating structure successfully generated, identified and characterized the HOMS of wakefields.
- Testing showed that the quality factor (Q) of the HOMs is significantly lower than that of the monopole mode.
- Testing demonstrated the intrinsic advantage of the PBG accelerating structure in terms of HOM suppression, which makes the structure a compelling candidate for future accelerator design.
- The technique used in this experiment could be used to study wakefields in other geometrically complicated accelerating structures.



Top: *Experimental setup in the AWA beamline.*

Bottom: *(a) Power spectrum of the typical wakefield signal from an off-axis bunch captured by the rf probe and the simulated electrical field pattern for each major mode; (b) Signal of the filtered fundamental monopole mode (11.55 GHz); (c) Signal of the filtered lowest dipole mode (14.46 GHz).*

"The advanced acceleration schemes we are developing here at Argonne, as well as our state-of-the-art facilities, will pave the way for future high energy physics discoveries," **said Wei Gai, accelerator physicist, Argonne National Laboratory.**